

## WHY IS A PARTICULAR CHILD RIGHT-HANDED OR LEFT-HANDED ?

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IF, as I believe, the study of civilized people shows that the special incidence of right-handedness, and of left-handedness, and of mixed types, is governed directly by ocular dominance, and only indirectly and partially by heredity, a thorough understanding of the subject will be gained by a preliminary look at the precedent animal function and habit. And this is epitomized as right-eye dominance of general dextral or right-side function, and left-eye dominance of general sinistral function. To begin with, embryology demonstrates the existence of vision long before muscles, so that historically and evolutionally vision governs motility; the very cleavage of the brain in the two so independent halves of all types was doubtless due to the unilateralism and independence of ocular function. The more primitive the type the more on one side of the head was the governing eye, and the more independent it was of its fellow upon the other side. A motion to strike one eye from its side does not cause the other eye to wink or to protect itself or the animal from injury. One eye governed one side of the body (because vision must incite and control all action), especially the co-ordinated front foot of that side, but also the hind one of that side to a less degree or less accurately; and the other eye acted for the other lateral organs in the same way. Fewer and less accurately co-ordinated commissural fibers between the two hemispheres were then necessary than when later complication and specialization arose. It is evident that when one eye was placed upon one side of the head, not looking forward, and separated from the other by a protruding mass of organs and bony structures, it must act independently of the other, to see ob-

jects upon that side of the body, to protect it, and to govern the muscles of its side. So long as the forefeet are equally used, i. e., so long as no differentiation of their function arises, there can be no question of the existence of right-handedness, or right-footedness. The chief, most frequent, most necessary of all animalian four-footed function is placing first one front foot, and then the other front foot, in the safe and right place and position, especially in rapid motion, fighting, defence, etc., etc. That placing of the right forefoot must be dominated by the right eye, and of the left forefoot by the left eye. There is simply divided dominance of the eyes, each supreme in the control of its correlated lateral organs. The peculiarities of the avoidance by a horse of a stone or log in the road, by, say, the right hind foot, the stone at the instant out of sight, and the right eye perhaps governing the avoidance of a similar impediment in front by the right forefoot, is a most instructive thing. The co-ordination of eye and front foot is more exact, and the very awkwardness of the hind foot is significant.

The approach toward binocularity, the advance of the eyes toward the front of the skull, the degree of forward-lookingness, if one may so speak, is measured and indicated by the progress toward parallelism of the ocular axes. Recapitulated, this progress towards parallelism is steady from lower to higher types, reaching complete parallelism only in man.

In the most civilized of humans, the literary and handicraft workers, the progress does not end with parallelism, but the ocular axes must be sharply converged upon a point 12 or 15 inches from the eyes for ten or

more hours a day.\* And with every step of this progress in human beings there must be a like increase of complexity in the inter-relations between the ocular government of common or bilateral movements and functions. The number of things to be seen by both eyes, and to be done by both hands, etc., is constantly increasing. But, *pari passu*, there is an equal differentiation and specialization of functions of the two hands. With every expertness gained, one hand is told off to that extremely specialized task, and the other perhaps to another, but at least never to the same. And still the old great rule, generally speaking, not only remains in force, but is increasingly observed: In the right-handed the dextral hand is chosen more and more for the heavier, the higher, more intellectual, more skilled, more difficult, more minute, more detailed task, and the left is still the holding, assisting, and complementary helper. In the left-handed the rule is reversed, but there is no inferiority in the expertness, etc., of the left hand in these cases, although 97 or 98 per cent. of their ancestors were right-handed.

The right-sided cerebral convolutions retain all the aptitude for governing skilled functions which the left half-brain possesses in the majority. The explanation of this seeming contradiction of evolutionary law is seen in the recognition of the fact that "the ontogeny still repeats the phylogeny"—for right-handedness and left-handedness is not prenatal in origin. It begins with the infant's coincident function of eye and hand, and begins at the period of ontogenetic development corresponding to that of the phylum when forefeet began to be used as hands, and when one hand began to be preferentially or necessarily used for a special task. In human historic development it emerges into clear view with the specialization of the left as the shield-hand and holding hand, and of the right as the spear-hand, the counting-hand, etc., and finally as the writing-

hand. It is thus a late acquirement of the phylum. Thus the individual born now begins to acquire it, for either half-brain, at about six months of age, and the left-handed is as quick to learn it and is just as expert with his left hand as his right-handed brother with his right hand.

Two things need to be recognized, emphasized, and always borne in mind: First, there is no inheritance of completed mechanism, or even of predisposition towards it. Either cerebral hemisphere may be the seat of the speech-center, and it may innervate the more expert hand, with absolutely no inferiority of expertness in the less commonly chosen right half-brain.\* Thus heredity has, directly, nothing whatever to do with the existence of 97 or 98 per cent. of right-handed, and 2 or 3 per cent. of left-handed. If those who are Mendel-crazed, or who see "the iron and adamantine law of inheritance" in everything, ever tried to trace such supposed laws in the incidence of right-handedness, they quickly abandoned the hunt. Because they found that here no such "iron law" exists (it exists nowhere, forsooth!), and that some other mysterious agency is at work, of which they could have no knowledge. "The wind bloweth where it listeth," and the least, or the most, investigation of actual cases shows that left-handedness or right-handedness arises most incongruously for the iron-law-of-heredity criers, has even nothing to do with heredity directly. For several generations, e. g., neither paternal nor maternal ancestors of two children were left-handed, and suddenly these two children are found to be left-handed!

Secondly, just as there is no endowment of right-handedness or left-handedness, as a completed mechanism, nor even of any sign of an inherited exceptional aptitude, so there is no completedness of the acquirement. Every

\*Lack of converging power to carry this out gives the practical oculist his pathologic problems of exophoria and divergent strabismus.

\*The fact is a striking example of how little pathology of the laboratory kind has to do with life, function, or the origins of diseases. It is a matter of vast significance to a man whether he is right-handed or left-handed, or of mixed type. But millions of slides by all pathologists could not tell to which class the dead man belonged.

baby of a year of age shows some beginnings of the peculiar expertness, but the progress in specialization and in the acquirement of kinds and degrees of expertness never ceases while life lasts. And there are as many mixes of peculiarities as there are individuals; there are almost as many anomalous as there are typical cases. As a rule, of course, the hand chosen for the most expert tasks is increasingly chosen, and people tend to fall into two great classes, the right-handed and the left-handed. All left-handed mechanics (and now everybody uses machines!) are handicapped and bothered by the fact that all machines, even to screws, are made for the right-handed. Not to be forgotten also is the number, large in the aggregate, of the right-handed who, by accident, injury, etc., lose the superior expertness of the right eye, right hand, right leg or foot; and, conversely, the number of the left-handed who suffer similarly as regards their sinistral expertness. In such cases there is a transfer of task to the opposite organs, and a slow, difficult, and always imperfect expertness is acquired. But in every case there is a crippling, and a lessening of productive capacity, a disadvantaging in the struggle. And more surely is there a mixing from the ground up, or rather from the top of the head down, of hitherto co-ordinated and related functions. The center for the intermediation of an absolutely necessary psychic and neurologic datum to the engineered composite act has to be transferred to the opposite side of the brain. There is, of course, halting, indecision, slowness, or genuine inhibition of function because of the difficulty of correlating the data from the two sides of the brain. Many a case of stuttering, probably most, slowness and morbidities of speech, etc., are due to this division or misplacement of the innervating centers in opposed cerebral hemispheres—all bound with right-eyeness, right-handedness, or the opposites, etc.

Think also of the appalling amount of misery, mental and physical, the

disease, the shame, that for untold ages has been thrust upon the left-handed by parents, social custom, etc. There is even now scarcely a poor left-handed child who is not cursed by the attempt to make him right-handed. There are about three million naturally left-handed in the United States! Every one of them, if not absolutely diseased, is made morbid, less happy, handicapped, by the peculiarity a little, by the cruelty of changing it a vast deal. Add the millions of millions that must have lived since the first finger of the dextral hand was held up in counting! In savage times the savage mother and father, and tribe, must have horribly maltreated the poor unfortunates. There is only a little proof of this in the *Keep to the Right* of our common law, in the wrong and ignominy associated with the words *sinister*, *gauche*, etc., and the honor born of mere contrast, of course, in *right*, *dextrous*, *dexterity*, etc.

Focus the converging lines of the argument! The 97 per cent. by all laws of inheritance and of mechanics should long ago have extinguished the relatively few left-handed anomalies. They persist, and perhaps increasingly. The mixed types are certainly increasing. The vindictive effect of persecution, shame, and cruelty, united to the number of the mutilated, would add powerfully to exclude them in the long history of human evolution. They reappear as numerous, as mysteriously, apparently as illogically as ever, and certainly in mockery of any known law of heredity. Why?

To understand the answer it should be remembered that forward movement of a four-footed animal, composed of two poorly united or co-ordinated longitudinal halves, must be by means of the governors of all movement—vision. One organ of this vision was for the one badly co-ordinated half-body, the other for the opposite half. The brain was halved, also, but a slow and poor correlating mechanism was begun and is being improved, at present much improved. Even now the right eye is united in function with the right hand, the



right foot, etc., and especially with language, the crowning achievement of humanization. The centers of right-eyedness, right-handedness, right-footedness, speech and writing (with memory and intellect) must be topographically in the left cerebral hemisphere to insure speed, accuracy, and co-ordination of united sensation, thought, will, and action. In the left-handed, of course, the same law holds of the right side of the brain. In one or in the other, therefore a little by inheritance, and more by necessity—but not divided or mixed! That is disease—and the god of evolution is a physiologist, not a pathologist! (He seems to have made some pathologists, but not intentionally; and they are pathological!)

The right cerebral mechanism, although disused for speech-function and right-hand function for 97 per cent. of all ancestors, and for a special family group, for untold generations, still retains an equal aptitude and mechanism for function with the left. The peripheral mechanism of left hand, left foot, etc., also retain their co-equal educability and proficiency. What varies, and what is the special variant cause beyond the complete control of the biologic mechanic, which induces the individual incidence of right-handedness and of left-handedness?

It is the eyeball. I have measured 20,000 or 30,000, and no one was perfect in shape. It is a poor and makeshift mechanism apart from its morphology; but, so difficult, so impossible, is the task of making it mathematically perfect in shape, i. e., to one-three-hundredth of an inch of ametropia (and that may be pathologic in resultant function) that such perfection of dimensions has been impossible. An approach to that perfection has been attained in the ages, and by means of that most powerful of all the agents, the exclusion of the unfit, the exclusion of the ocularly unfit.

When the child begins to reach out for and to seize upon objects with its hands, the question arises at once—with which hand? One is usually all

that is necessary, and one must be selected. Then begins either the lifelong and increasing preference, selection, and selectability of the right, or of the left—or the history and perfecting of right-handedness, or of left-handedness. The significant thing is the order in which the peripheral functions appear and develop in the child. First of all, long preceding, causing, and governing all others, especially of motion, is Vision. The lesson of embryology is illustrated in the baby's life. When the muscles of the arm and hand are ready for any movement, vision has been long ready to direct it and make it purposive. Then the correlated center for speech-phonation is located in the brain-half opposite that of the dextral eye in the right-eyed, and vice-versa in the left-eyed. The foot-and-leg correlation is latest and always most imperfect and variant.

Many tests may be made of the now well-known fact I have so long urged of the dominance of one eye in vision; of the existence, under certain circumstances, of two images of one object (not strabismic, but normal and necessary); and of the psychic ignoring of the image of the non-dominant eye. A sheet of paper vertically held before the eye, with the edge against the nose, followed by alternate closure and opening of each eye illustrates; or the pencil or finger may be held in most any position and the gaze fixed beyond it. Other devices prove that certainty of manual seizure, accuracy of mental re-presentations of spacial, topographic, and stereoscopic relations (with precision, safety, etc., of co-ordinated actions) depend upon the frequent preference of the image of one eye, and the ignoring of that of the other. The right eye and right hand must work together, the right eye usually governing the actions of the right hand; and the same of the sinistral organs.

If now the right eye is more defective, more ametropic, if its vision is poorer, more difficult, or more painful than that of the left, the left eye must be chosen to govern hand-action,

and so, of course, the left hand will become habitually the more chosen, the more expert, and the more educated, for the special task, and soon the child is seen to be left-handed! Fight it all, tie the left hand behind the back, beat it, shame the child? Not so; the cause, the faulty right eye, will remain uncorrected and unthought of by all such absurdities and cruelties.

In the 97 per cent. and at the beginning of the function of *handedness*, the right eye is the better eye. Even in adults oculists have found out that, as a large rule, the right eye is more nearly perfect than the left, is less subject to disease, accident, etc., and that the "unconscious" wisdom of the organism will protect and cure it more certainly than the left (except, of course, in the case of the left-eyed). And when right-eyedness is once established, Nature will preserve it in desite of later oncoming amblyopia, ametropia, or disease, which then handicap it much more than the left. The rôle of heredity is that of passing down the more nearly perfectly formed eyes and the more nearly perfect right eyeball. The directly acting exceptional cause is the more imperfectly functioning right one at the time handedness is to become either the right or the left variety. I could adduce a hundred clinical proofs of

this. And it is not to be forgotten that the babe's eyeballs are smaller, and hence more ametropic than larger eyeballs, surely more hyperopic morphologically—a fact of most suggestive importance.

A hundred questions and considerations arise: Handicap the infant's left eye in beginning left-handedness? The problems of equidominance, and of divided dominance? The ophthalmic surgeon's duty in disease and operations? The blunder often committed by opticians and oculists of bad glasses which cripple the dominant, and stimulate the non-dominant eye? The treatment of the maimed, the one-eyed, the paralytics, etc.? The treatment of those so pathetically and badly wronged by the "ambidexterity" foolish ones? The prevention of the cases of 27 per cent. of all the population who have lateral curvature of the spine, caused by ocular function and ocular malfunction? The stopping of the horrid writing posture of everybody? The arousing of the medical world to the awful importance of the eyes as causes of a hundred diseases? The arousing of the Darwinians to the rôle of bad eyes as the great cause of the exclusion of the unfit? These and many such questions are, indeed, most living, most imperative, but not to be entered upon here.

